December 1969

Brief 69-10734

NASA TECH BRIEF

NASA Tech Briefs are issued to summarize specific innovations derived from the U.S. space program, to encourage their commercial application. Copies are available to the public at 15 cents each from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

A Simple Electrometer for Measuring Small Photoelectric Currents

The problem:

To devise a simple direct-indicating instrument for measuring small photoelectric currents of below 10^{-15} amp.

The solution:

The quartz-fiber direct-indicating pocket dosimeter is, in fact, a small-current integrating electrometer. By attaching the photocathode to the quartz fiber terminal and the photoelectron collector to the barrel of the dosimeter, and by charging the device to 150V, a simple direct-indicating small-current measuring device can be achieved. A soft X-ray beam falling on the photocathode causes a small current to pass between the photocathode and the collector, thus discharging the dosimeter. By observing the rate of discharge (the number of scale divisions per unit of time), the photoelectric yield of the photocathode can be determined. The average leakage of the device is less than 1% of the full scale in 24 hours.

How it's done:

The pocket dosimeter used in this case is equipped with a bellows-charging switch that must be depressed to charge or discharge the device. This switch protects the electrometer of the dosimeter from the ambient environment. It is removed in the modification to ensure a permanent positive contact between the photocathode and the electrometer. The photoelectron collector is connected to the dosimeter barrel. A light source of high intensity is used to illuminate the scale of the dosimeter, which is graduated from 0 to 200 mr in units of 10 mr. By using a telescope to read the scale, it is possible to break down each 10 mr unit further into 1 mr units. A battery is employed to charge the electrometer system through electromagnetically actuated relays. The photoelectron collector is grounded to prevent background leakage of current between the collector and its surroundings. Readings are taken in all cases with the leading edge of the quartz fiber indicator. The following table gives the specifications of the integrating electrometer device described above.

Capacitance	$2.6 \pm .2$ mmf
Scale Reading	0-200 mr (10-mr units)
Maximum Charging Voltage (0 mr)	148 V
Minimum Voltage (200 mr)	125V
Voltage Differential for Full Scale Change	23 ± 1V
Total Discharge	$6 \pm 1X10^{-11}$ Coulomb
Leakage Rate	12 mr/24 hrs. or 0.4 mr/hr
Minimum Detectable Charge	1 mr/hr. or $3X10^{-13}$ coulomb/hr
Minimum Detectable Electron Intensity	550 electrons/sec
Minimum Detectable Current	8.5×10^{-17} amps

The integrating electrometer and photocathode are calibrated by using a 5 mc Fe^{55} X-ray source. The source is located at several fixed distances from the photocathode, and readings are taken at sequential time intervals from each of the fixed distances. A gas-flow proportional counter is employed to measure the source X-radiation at the fixed distances. The window of the proportional counter is placed at the same location as the photocathode relative to the X-ray source. In this manner, only the differences in detector areas and window transmission of the proportional counter must be measured to determine the absolute X-ray-intensity calibration of the electrometer.

(continued overleaf)

This document was prepared under the sponsorship of the National Aeronautics and Space Administration. Neither the United States Government nor any person acting on behalf of the United States Government assumes any liability resulting from the use of the information contained in this document, or warrants that such use will be free from privately owned rights.

Notes:

1. This innovation is in the production state of development. It is novel in that the integrating-electrometric properties of a pocket-type personal dosimeter can be utilized.
2. The device should be useful for measuring extremely small currents in such applications as the design and development of photoelectric and X-radiation instrumentation.
3. Requests for further information may be directed to:

Technology Utilization Officer
Goddard Space Flight Center
Greenbelt, Maryland 20771
Reference: TSP69-10734

Patent status:

No patent action is contemplated by NASA.

Source: American Machine and Foundry Co.
under contract to
Goddard Space Flight Center
(GSC-10603)